GOODRICH

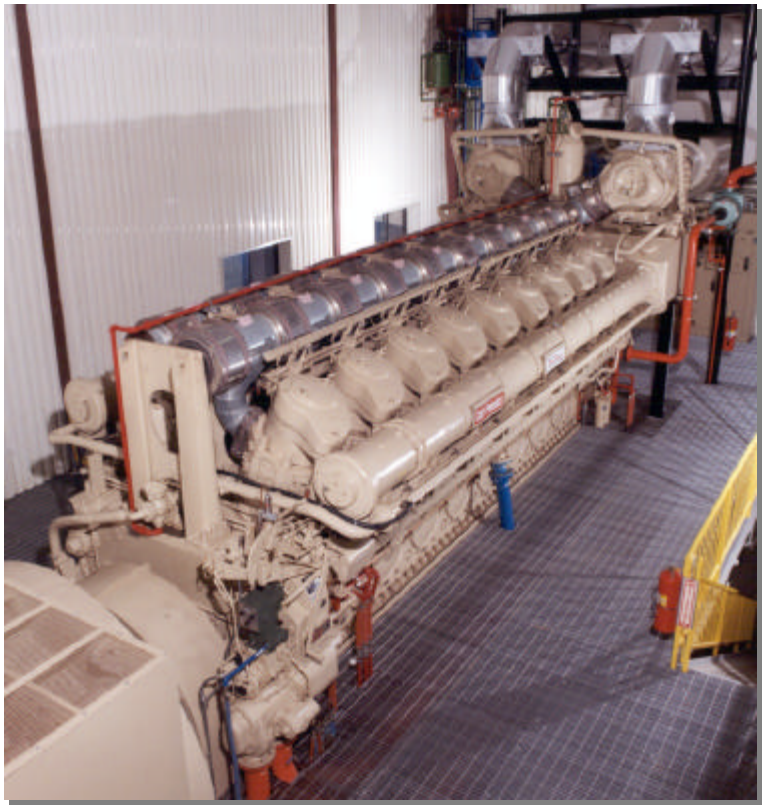
FAIRBANKS MORSE ENGINE

California Advanced Reciprocating Internal Combustion Engines Collaborative

Status of Fairbanks Morse Engine Products for Stationary Power Generation

Jay A. Burnette
Director, Marketing

FAIRBANKS MORSE ENGINE MARKETS



Stationary Power Generation
“Commercial”

Navy Propulsion and Electric Power Generation (SSDG)
“Government”

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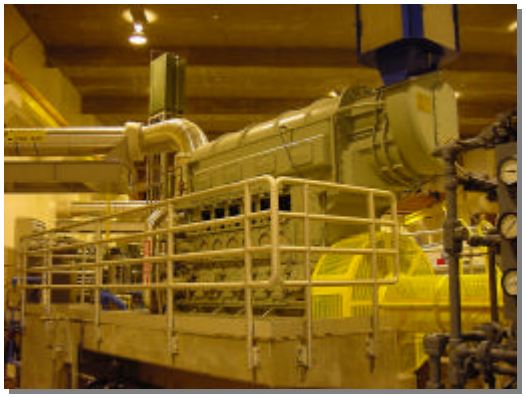
COMMERCIAL MARKETS

Electric Power Generation

- Target Customers
  - Municipal Utilities
  - Hospitals / Universities / Industrial Organizations
  - Wastewater Treatment
- North American Focus
- Natural Gas - 1.5 to 7.8 MW

Medium Speed - Continuous / Peaking



Secondary Markets

- Industrial Drive (Pump Applications)
- Locomotive Traction (FM/Alco)
- Existing Customer Base

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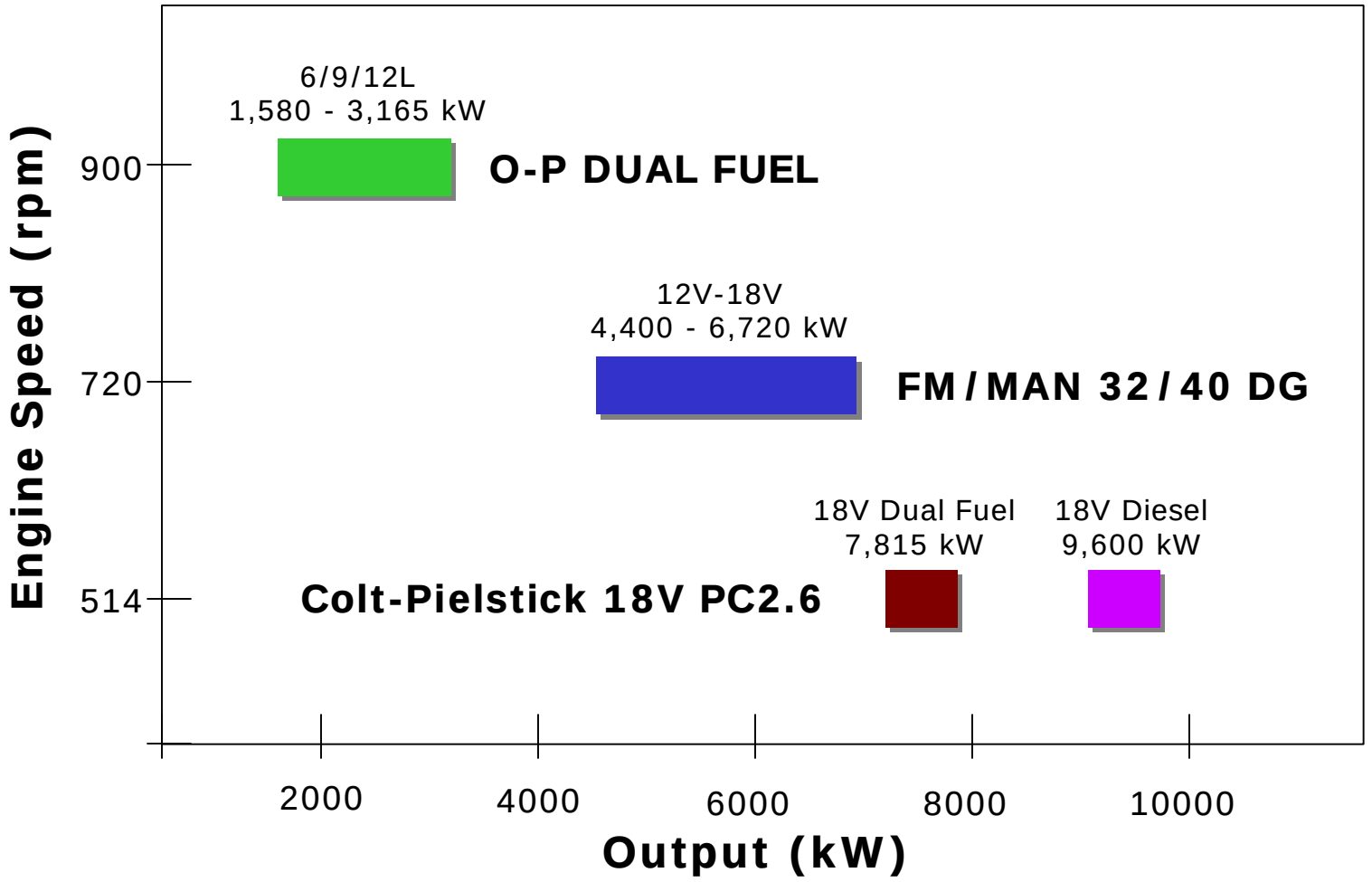
CURRENT PRODUCT LINES - EPG



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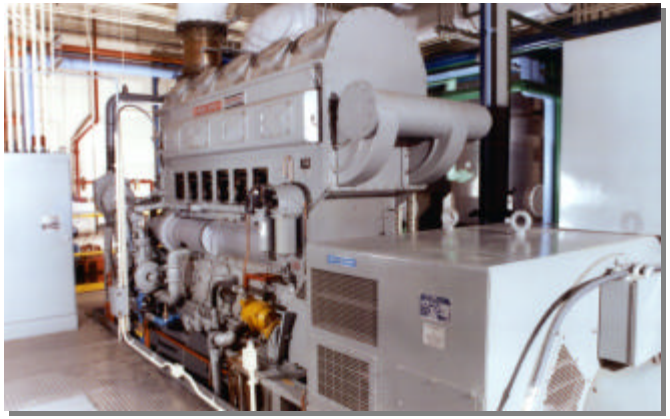
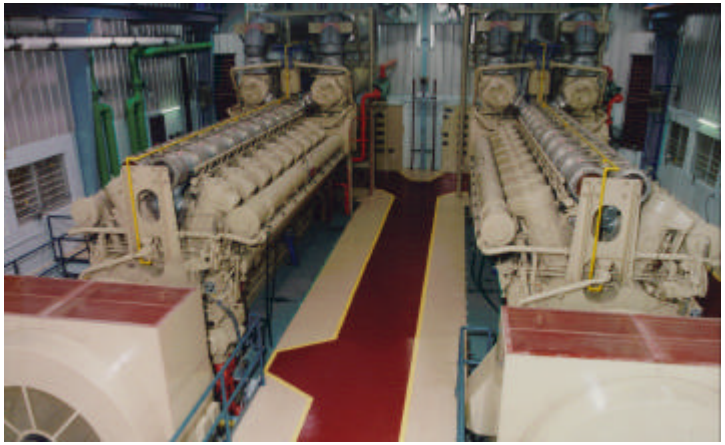
PRODUCT PERFORMANCE



- 1.0 gram/bhp-hr NOx (Uncontrolled)
- 0.1 gram/bhp-hr NOx (W/SCR)
- 41% efficiency



- 1.0 gram/bhp-hr NOx (Uncontrolled)
- 0.1 gram/bhp-hr NOx (W/SCR)
- 43% efficiency

- 1.0 gram/bhp-hr NOx (Uncontrolled)
- 0.1 gram/bhp-hr NOx (W/SCR)
- 42% efficiency

Fairbanks Morse Engine

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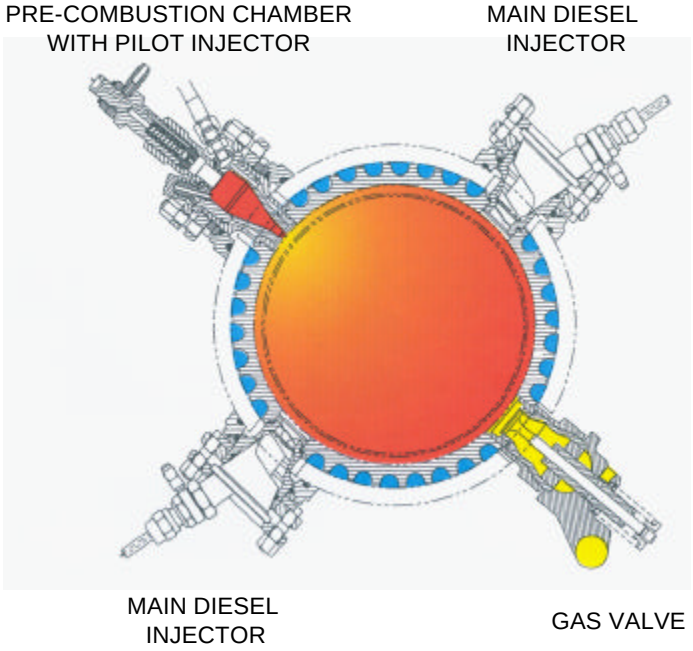
TECHNOLOGY FOCUS
ENVIRO-DESIGN® DUAL FUEL O-P



- Electro-Hydraulic Gas Valves and Pilot Injection - Q4 2001
- Electro-Hydraulic Injection for 100% Diesel Operation - Q2 2002

  "Cam-less" Engine
- Optimization of Heat Recovery Systems with 250° F Jacket Water
- **Emissions and After-treatment**
  - NOx - SCR
  - CO - Oxidation Catalyst
  - TAC's - Oxidation Catalyst
  - PM
  - Noise

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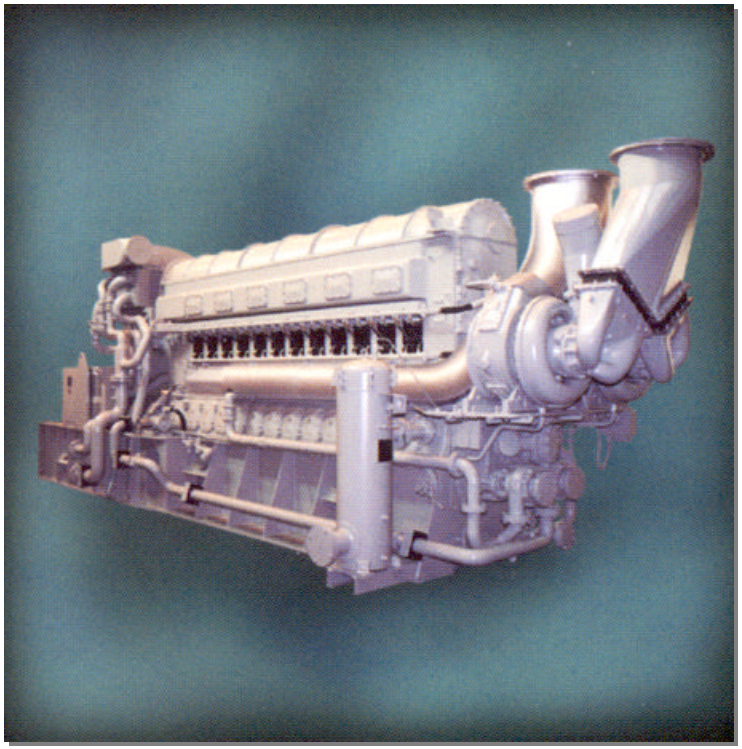
APPLICATIONS - CALIFORNIA



Chula Vista, CA

- 4 x 12 Cyl. Enviro-Design® O-P Units
- 3,165 kWe Each - 900 rpm
- Application - 24/7/365
- CHP - 265° F Hot Water
- Efficiency - 41% (w/o CHP)
- Overall Efficiency - > 80%
- Exhaust Emissions
  - NOx - 0.14 grams/bhp-hr
  - CO - 0.3 grams/bhp-hr
  - TAC's (Acrolein / Formaldehyde) with 90% RE
  - Combination SCR Oxi-Catalyst System
  - Avoided "Major Source" Status

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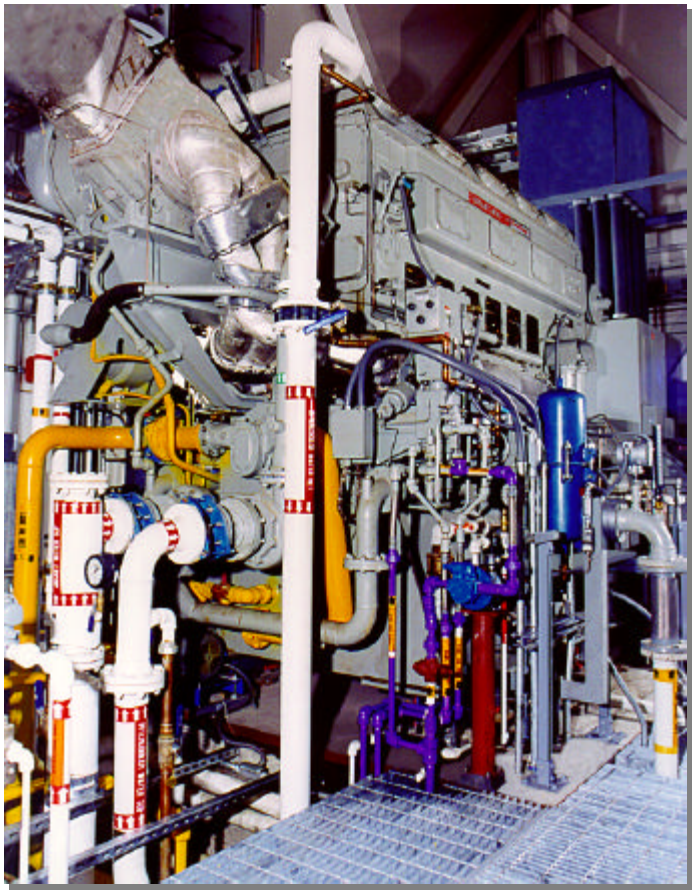
APPLICATIONS - CALIFORNIA



<u>San Francisco State University</u>

- 1 x 6 Cyl. Enviro-Design® O-P Unit
- 1,290 kWe - 720 rpm
- Application - Peaking and 24/7/365
- CHP - 175° F Hot Water
- Efficiency - 41% (w/o CHP)
- Overall Efficiency - > 85%
- Exhaust Emissions
  - NOx - 1.0 gram/bhp-hr
  - CO - 2.0 grams/bhp-hr
  - <u>NO AFTER-TREATMENT</u>

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EMISSIONS PERFORMANCE - CALIFORNIA
"THE GOOD NEWS"

Bay Area AQMD 

San Diego APCD 

South Coast AQMD 

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TECHNICAL CHALLENGES TO IMPROVEMENT

- Cost Effective SCR Technology for "Ultra" Lean Combustion (and Exhaust Temperatures < 700° F)
- In-Cylinder Combustion Efficiency
- Sensor and Controls Technology
- After-treatment for TAC's
- Alternative Ignition Sources
- Increased BMEP

"Controlling all of the variables in order to sustain high efficiency, low emissions and high reliability / durability. . ."